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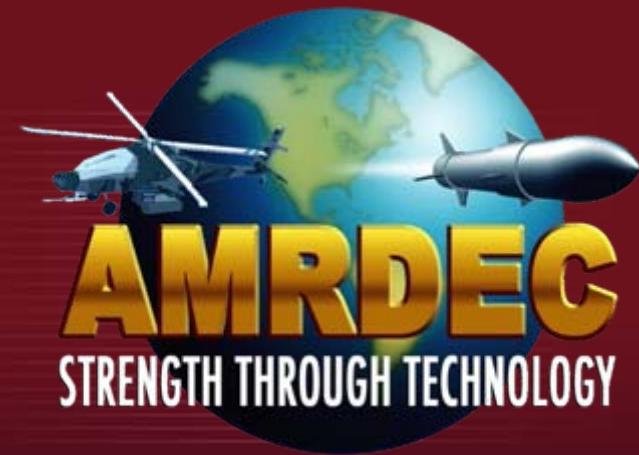
# Geographically Distributed Stimulation Architecture For Missile Defense System HWIL Weapon Facilities

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

20 November 2008

**Presented to:**

AIAA Missile Science Conference



**Presented by:**

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**Aviation and Missile Research,  
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# Geographically Distributed Stimulation Architecture For Missile Defense System HWIL Weapon Facilities

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# Agenda

- **Distributed Single Stimulation Framework (DSSF) Objectives**
- **Notional Scenarios to be represented**
- **DSSF Design and Truth Data Flow**
- **Software Architecture**
- **Hardware Architecture**
- **Summary**

# Why a Single Stimulation Framework

- The goal of a Geographically Distributed HWIL event is usually system-level interoperability and performance evaluation
- System-level evaluation requires centralized control and commonality of inputs to ensure all participating elements are acting upon the same information
- Inconsistent representation of physics can inject test-induced errors into the performance of the system
- If Element “A” processes threat system “X” one way, and Element “B” processes it another and both send data to Element “C”, artificial errors may be injected into the test that lead to false performance results

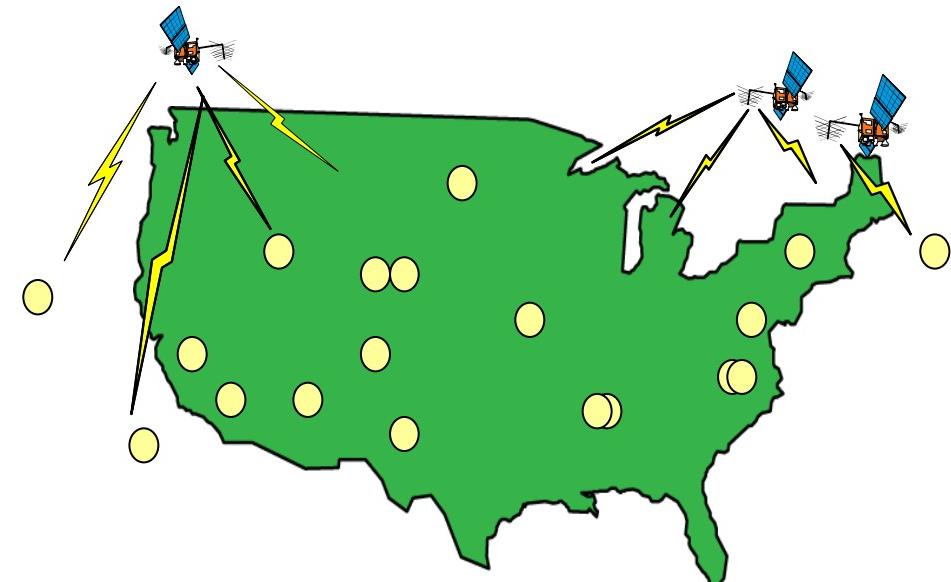
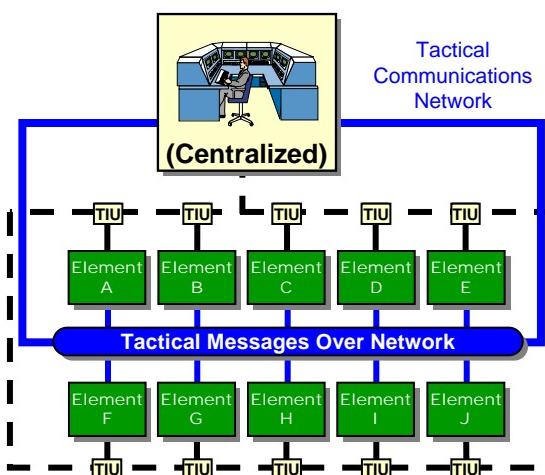


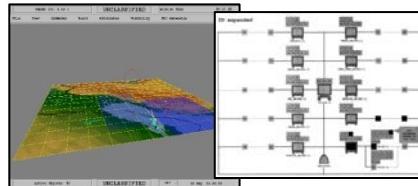
Figure: Example of Distributed Locations used in a Ground Test Architecture



# Distributed Single Stimulation Framework is...



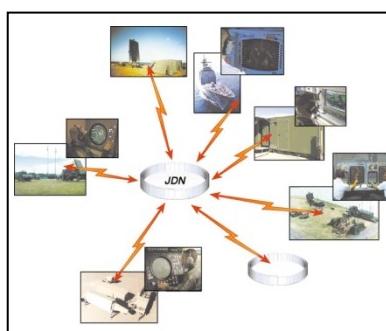
## Coordinated Planning and Control



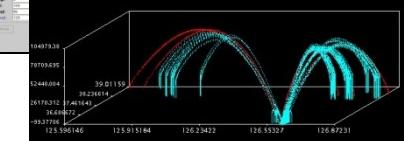
## Monitor Event with Truth and Perceived Activity



## Post-Event Data Collection and Assessment



## Distributed Real-Time HWIL Connectivity



...Verified, Validated, and Accredited Hardware-in-the-Loop (HWIL) Stimulation Tool

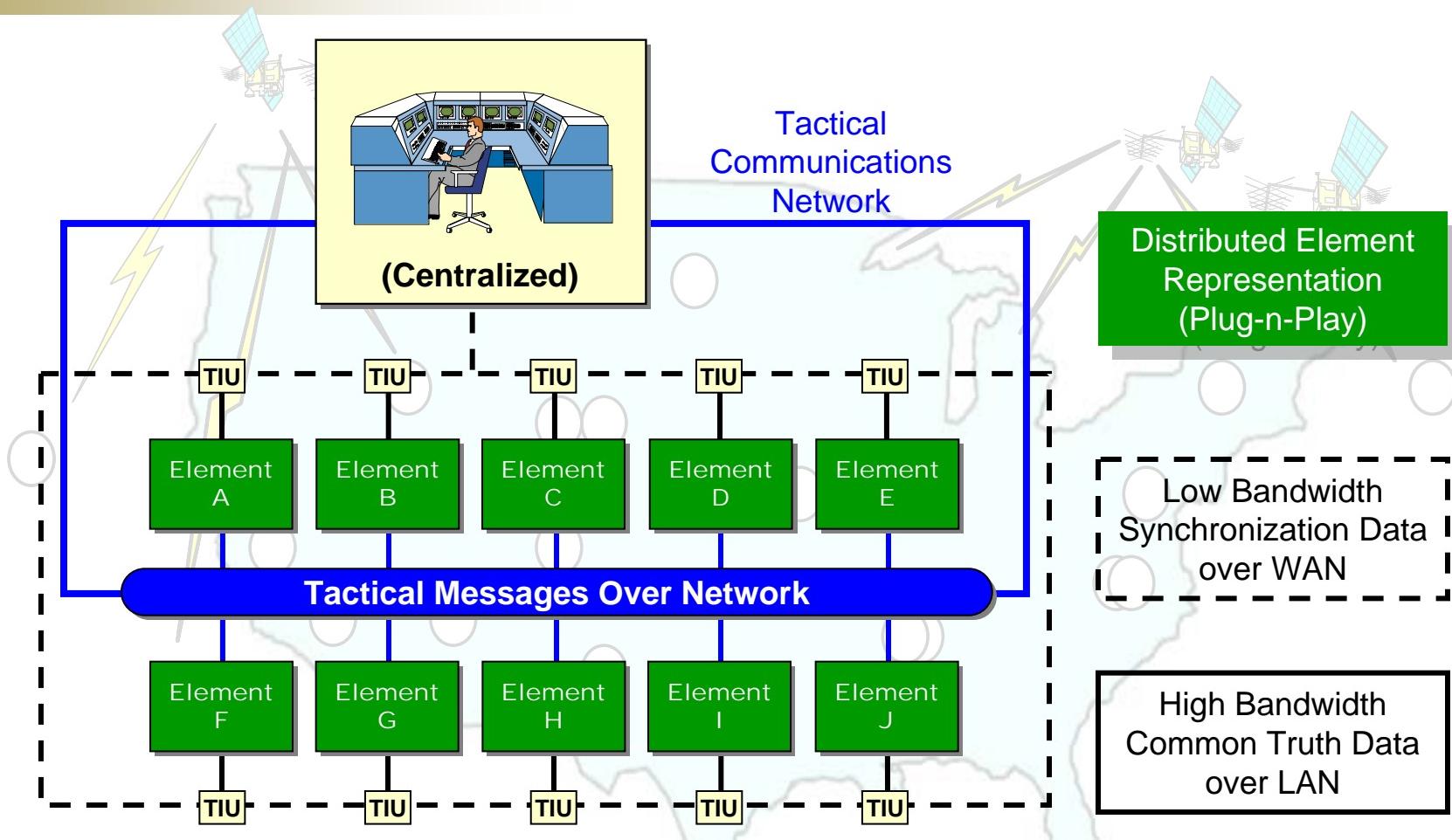
...Uses Approved Threats to Stimulate Tactical HW & SW Elements

...Link the Elements that Produce the Operational Messages

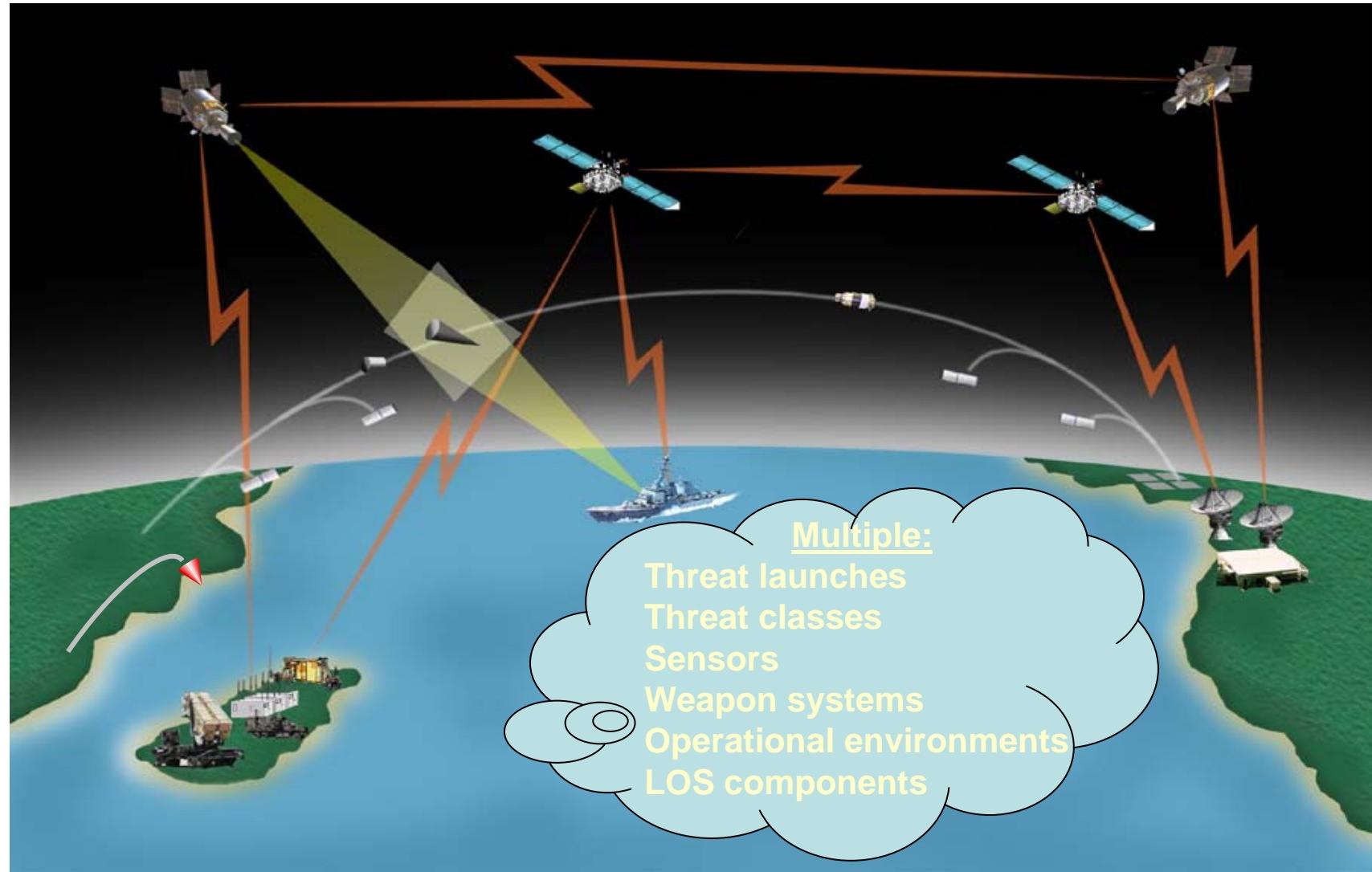
...Provide Characterization and Assessment of Units Under Test

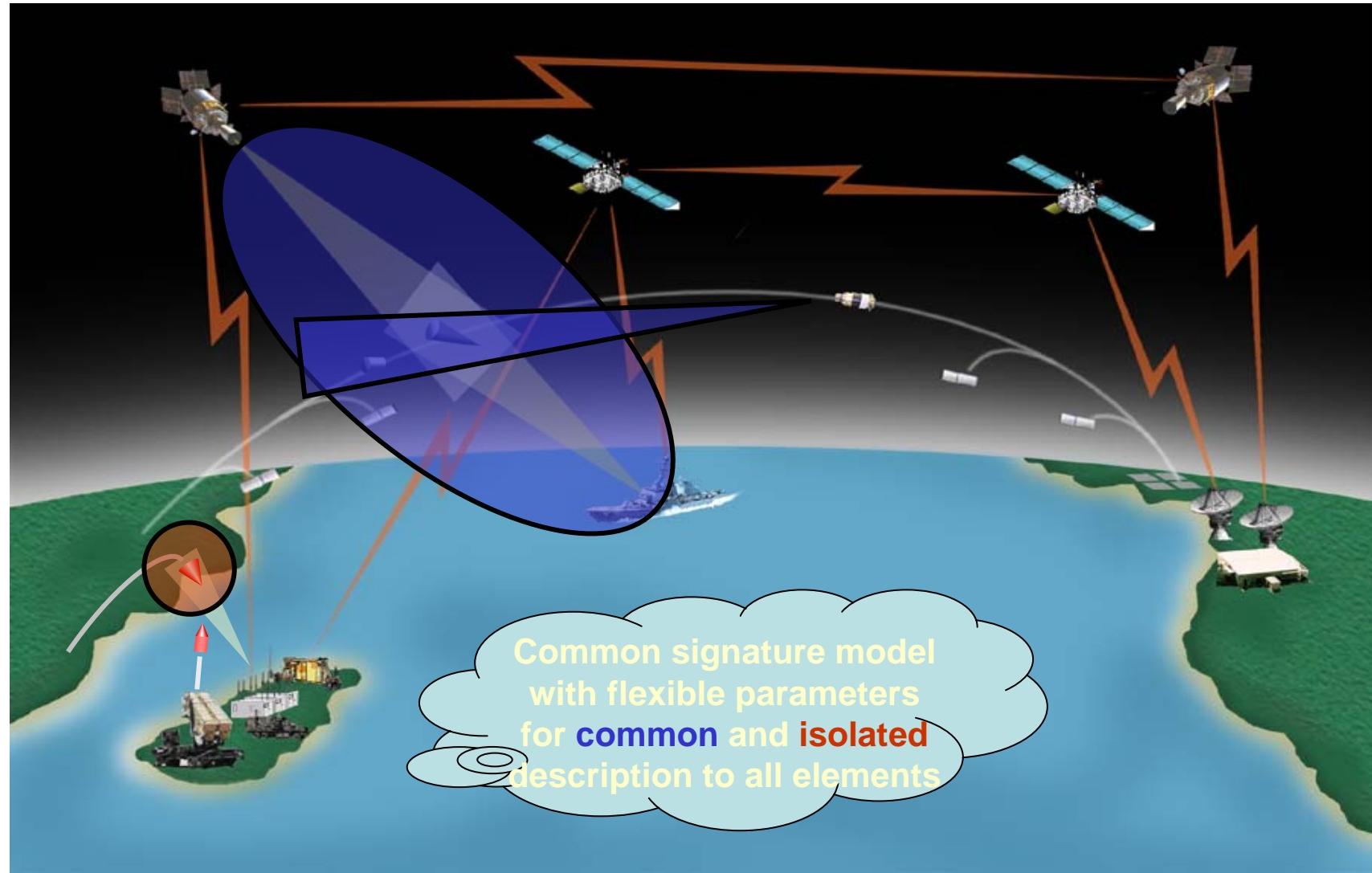
Real-Time,  
Dynamic, Interactive,  
Centrally Controlled,  
Geographically Distributed,  
GPS Synchronized  
System

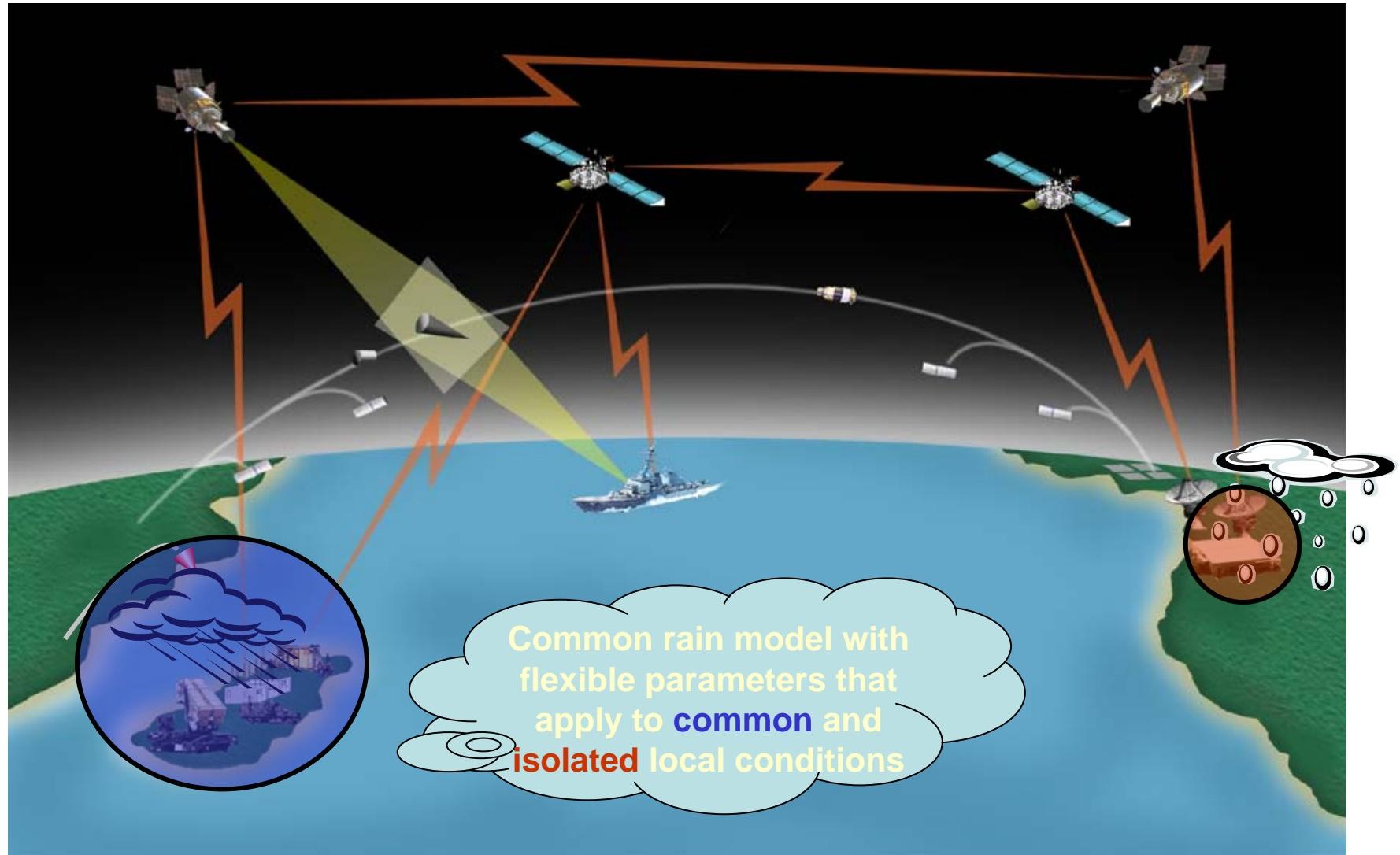
# Stimulation Framework Integrated Architecture Summary



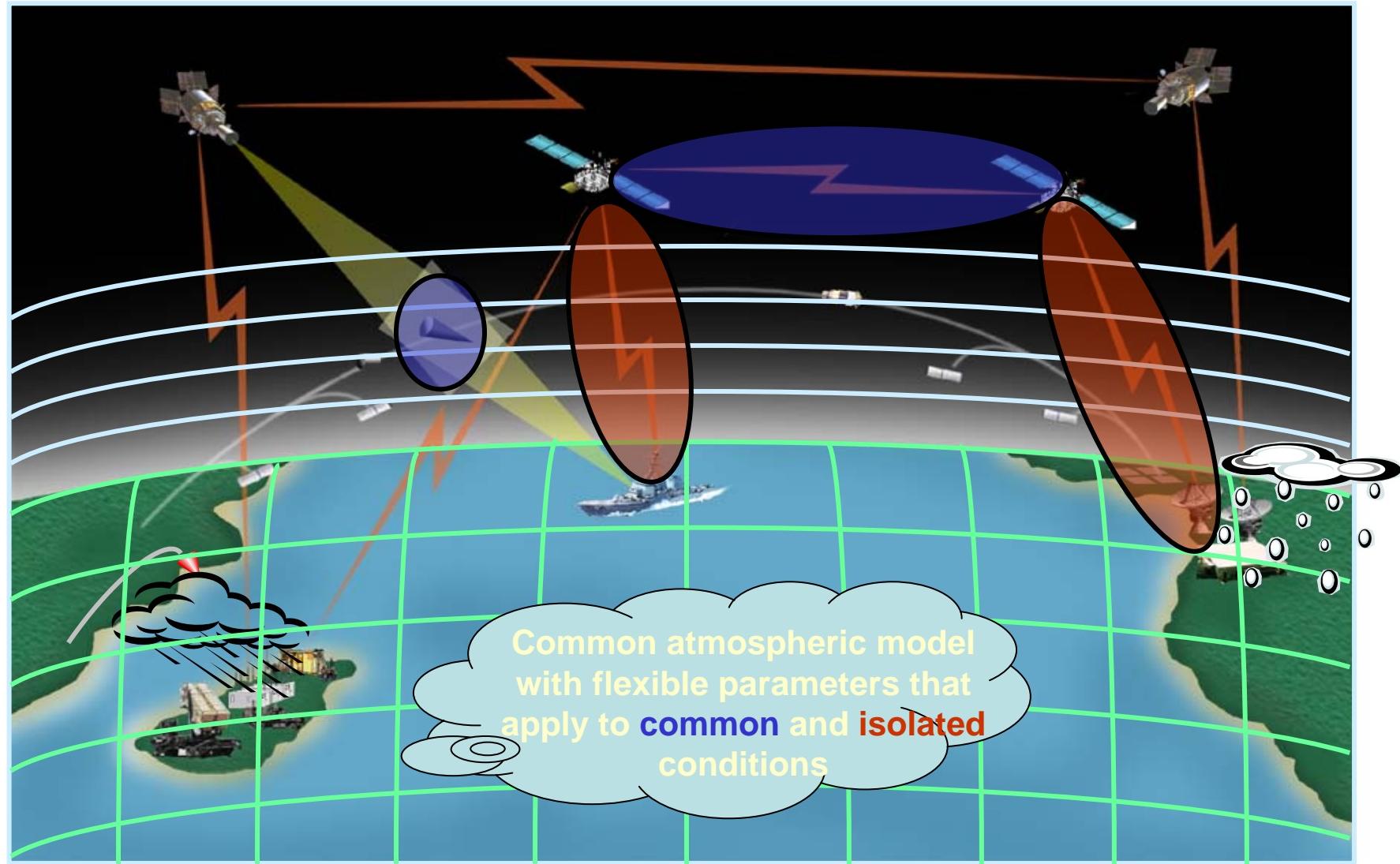
The Single Stimulation Framework Provides Centralized Control of Geographically Distributed System Components With Message Traffic Designed to Accommodate Network Capabilities and Allows for Easy System Reconfiguration to Test System Interoperability and Performance



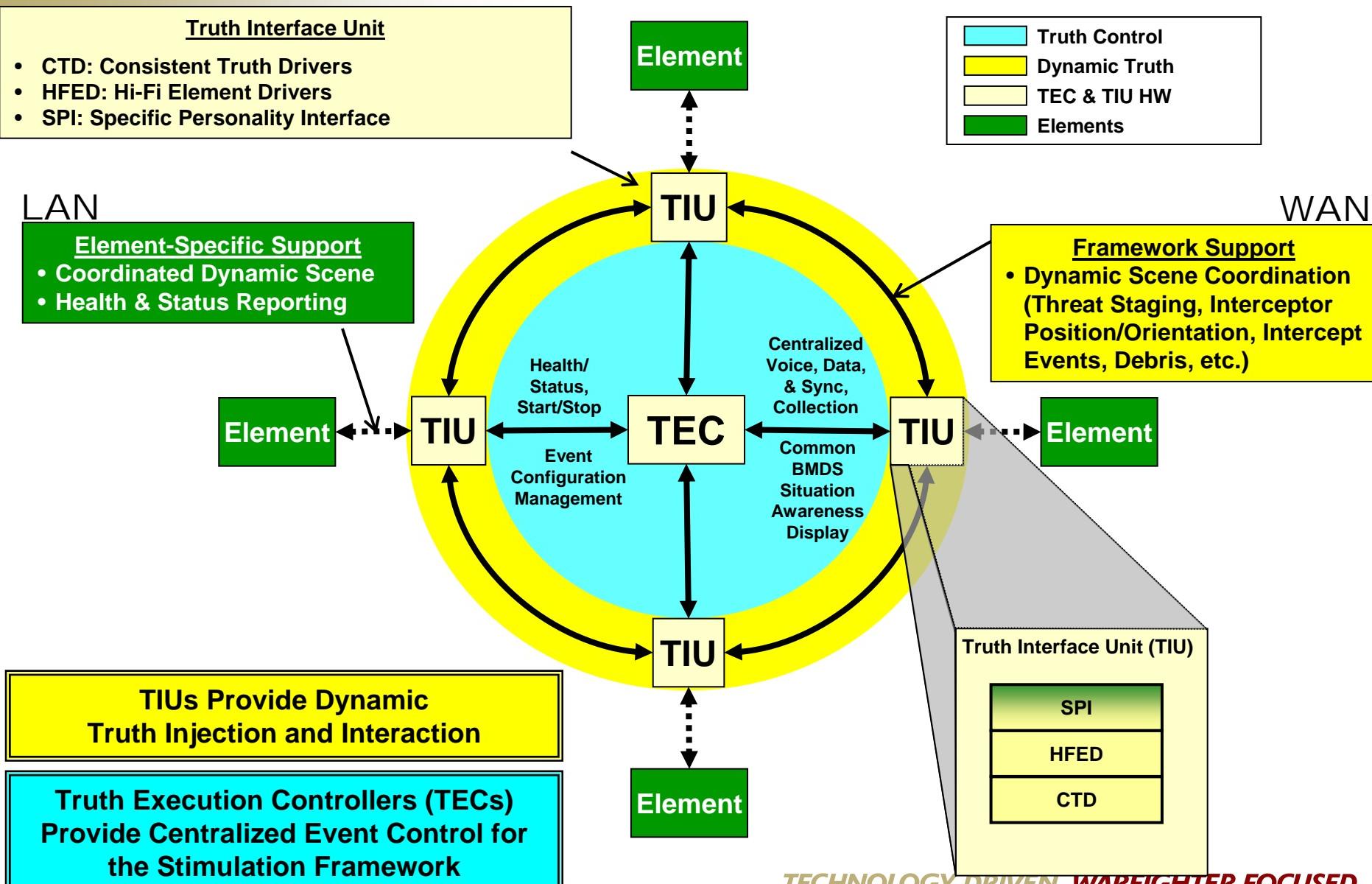




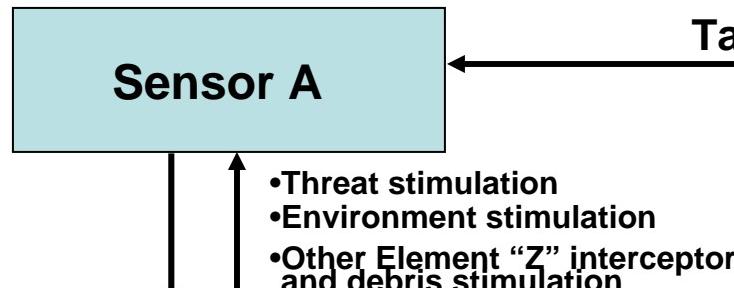
# Environments in HWIL -Atmospheric Model-



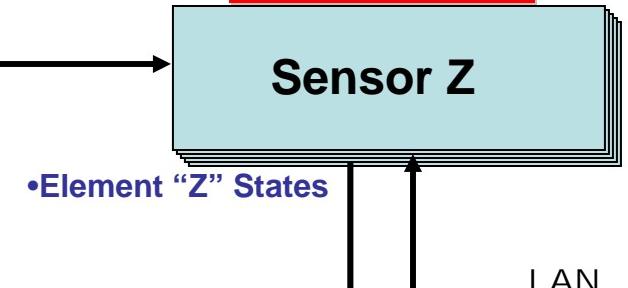
# Multi-Element Stimulation Framework Design



## Element A



## Element Z



## Truth Interface Unit (TIU)

- Scenario download
- Scenario set-up parameters
- Start/Stop
- Threat removal (Element "Z")
- Threat debris (Element "Z")
- Other element interceptor (Element "Z")
- Other element interceptor debris (Element Z")

- Sim Health and Status
- Threat removal
- Threat debris
- Test data upload

## Truth Interface Unit (TIU)

- Scenario download
- Scenario set-up parameters
- Start/Stop
- Health and Status query

## Truth Execution Controller (TEC)

- Scenario set-up confirmation
- Test configuration
- Sim Health and Status
- Test data upload

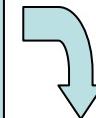
## Truth Network

All truth data exchanges are defined in the Interface Control Document (ICD)

- Truth Network Data
  - Scenario download from TEC to TIU
  - Event Test Start/Stop
  - Event Test Health and Status
  - Interceptor position, velocity, and acceleration truth data from Element A to TEC and Elements Z
  - Interceptor debris truth data from Element A to TEC and Elements Z
  - Threat detonation/removal from Element A to TEC and Elements Z
  - Threat debris truth data from Element A to TEC and Elements Z
  - *No tactical communication messages/data from Element sensor or Element Battle Managers*
- Operational Network Data
  - Sensor track data from Element A to Elements Z
  - Battle Manager control and response messages
  - Tactical action reporting
  - Operational Health and Status
  - *No truth stimulation or event control data*

## Pre-Mission

- Define Test Cases for event
- Parse trajectories
- Blue force laydown
- Radar Cross Section and Electro Optical data
- Other Test Configuration parameters
- Test Case download to TIUs



## Mission

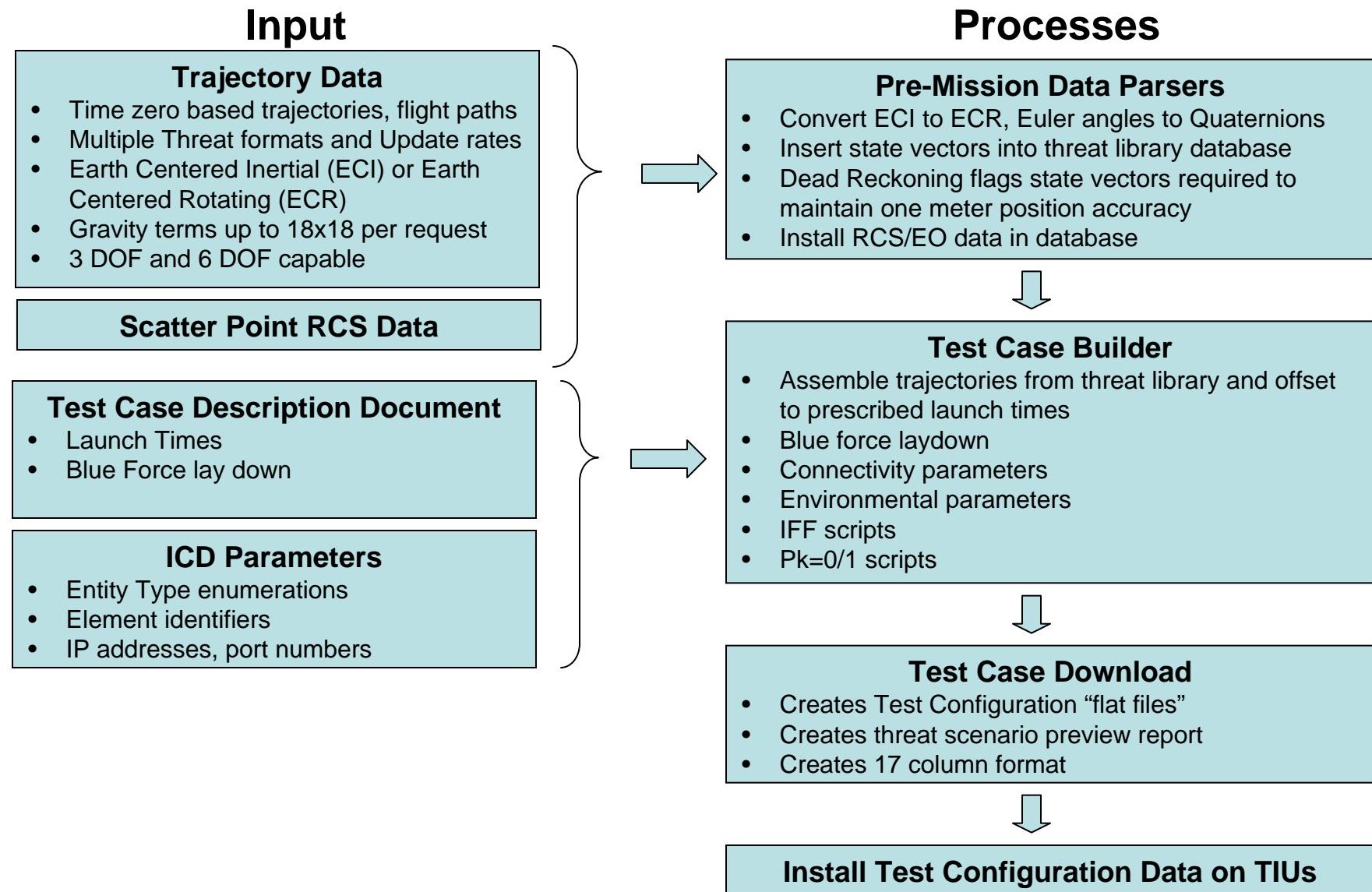
- Establish test control voice
- TEC starts Health & Status reporting cycles
- TEC exchanges initiation parameters with elements
- TEC issues Start
- Event Test start
- TIUs begin threat state injection to elements
- TIUs distribute “own-ship” state vectors from elements
- TIUs distribute interceptor state vectors
- TIUs propagate engagement debris for kills
- TEC displays H&S, truth and tactical msg track data
- TEC requests test integrity metrics
- TEC issues Stop

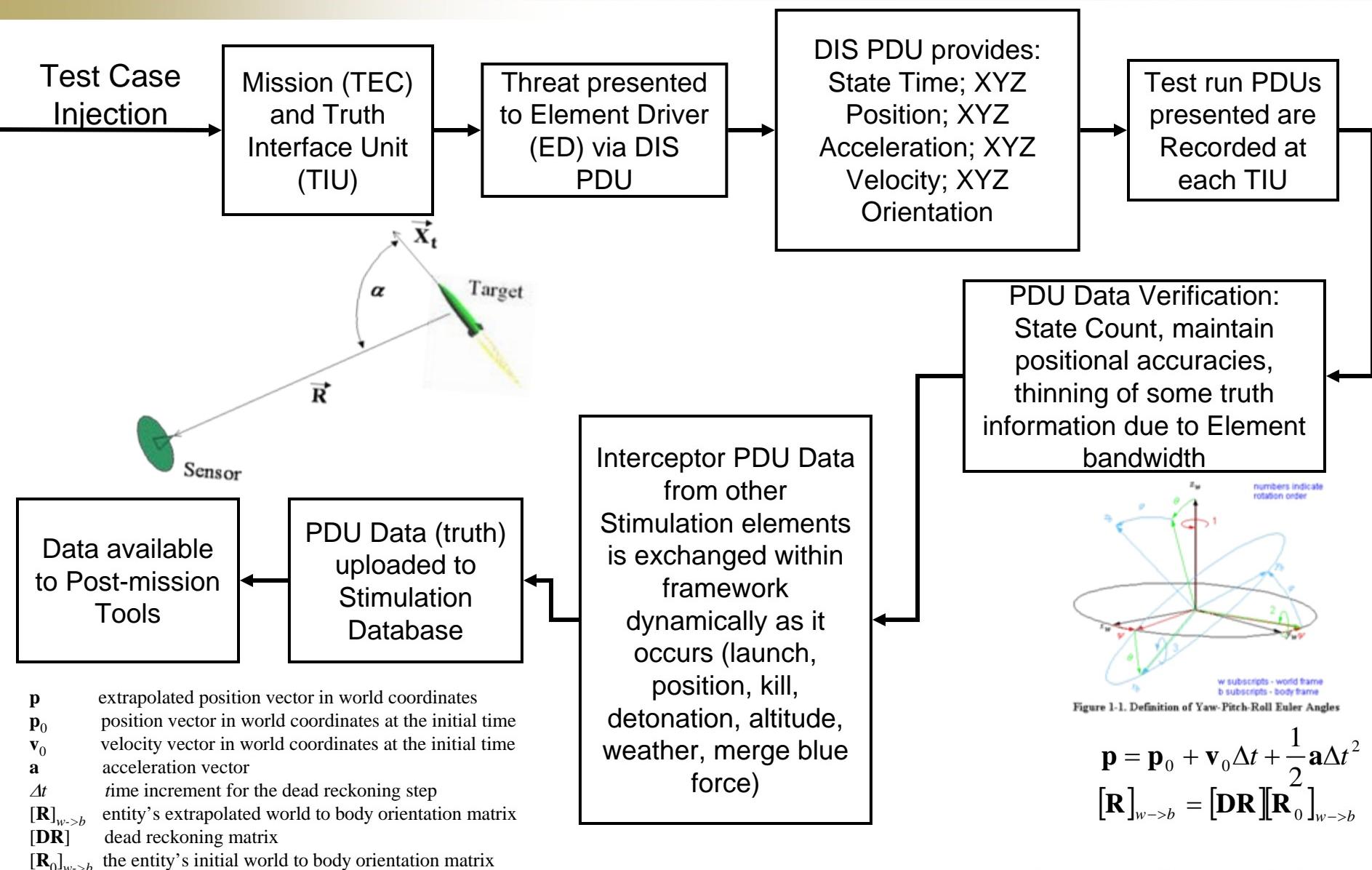


## Post-Mission

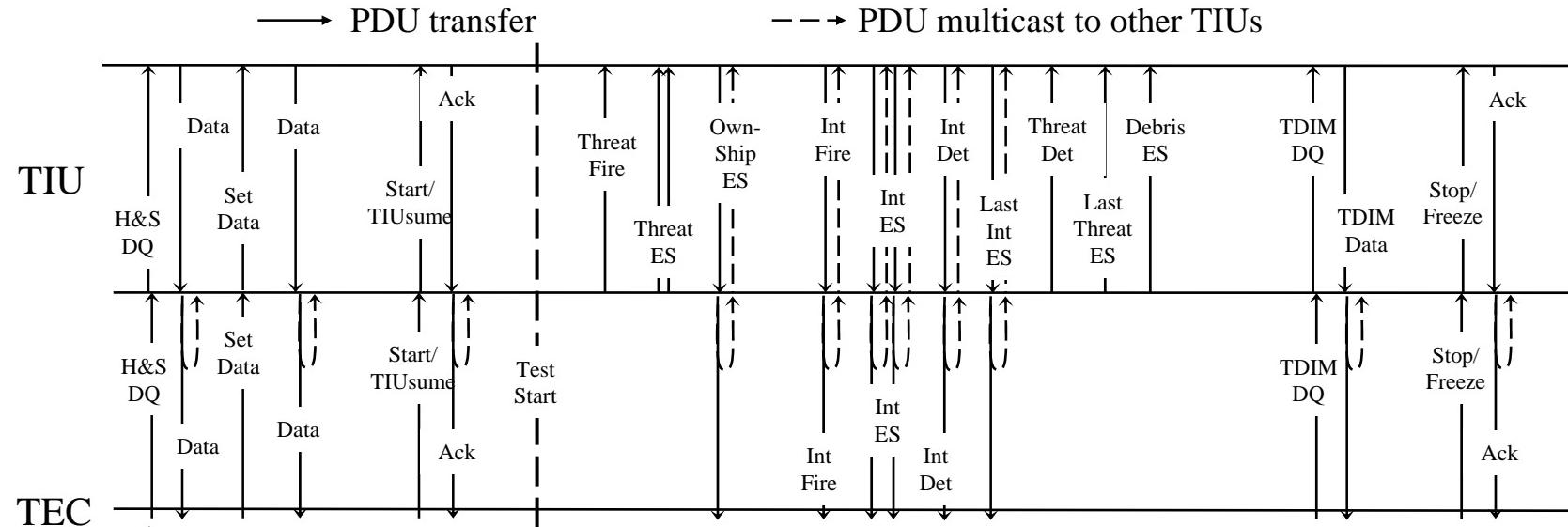
- Data file upload from all elements
- Parse data into Oracle database
- Data file status report
- Quick-Look report
- Database queries, plots
- Analytical tools
- Data file download

**Software is government-owned,  
developed, and non-proprietary**





## PDU Message Sequence for TEC and TIUs



## Major Mission SW Functions

- TEC and TIU use same SW
- TEC provides operator test and control
- TIUs can operate in stand-alone with Element
- TIUs convert trajectory files to ES PDU stream
- TIUs forward PDUs received from Element
- TIUs propagate engagement debris for kills
- TEC displays H&S, truth and tactical msg track data
- Data collection

## Data Flow

### Test Conductor

- Creates Test Run in Oracle database



### Test Participants

- Log-in to database at appropriate TEC
- Submit Test Assessment Form (if required)
- Upload data files



### Data Transformers

- Attach raw data files to test run
- Parse multiple message types and Correlation data into database tables
- Create Quick-Look Report



### Data Users on Truth Network

- Log-in to database at appropriate TEC
- Select Test Run of interest
- Can download any raw data file
- Can query and plot data from any database table
- Can use analytical tools
- Can export query, tool output tables

## Post-Mission Features

### Playback

- User at TEC can playback recorded truth and tactical events on display
- User at TEC can playback voice recordings

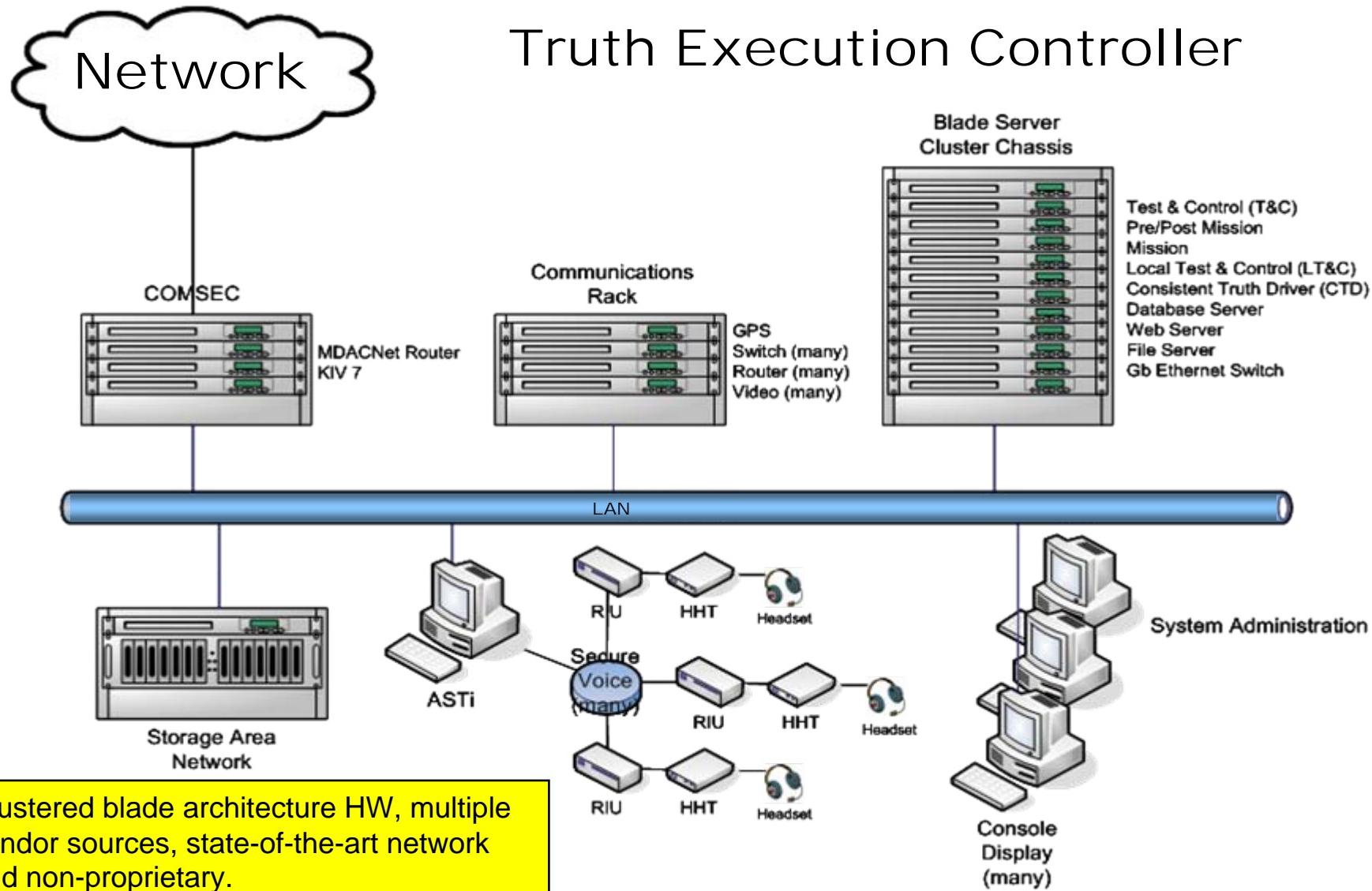
### Analytical Tools

- Verify PDUs
- Verify Tactical Messages
- PDU Message Transmission Delay
- Tactical Message Transmission Delay
- Extract Object History
- Extract Track History
- Find Close Entities for Tactical Track Msgs
- Engagement Summary
- Track Correlation Summary
- Volume Entry and Exit

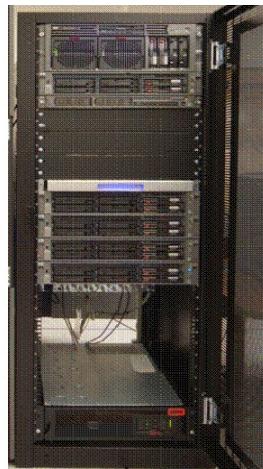
### Access Control

### Data File Status Report

### Quick Look Report



Clustered blade architecture HW, multiple vendor sources, state-of-the-art network and non-proprietary.



### Truth Interface Unit – Rack (TIU-R)

- Highest Storage Capacity
- Processor Scalable
- Full Environment Stimulation capability
- TEC-Capable
- Transportable
- \$\$\$

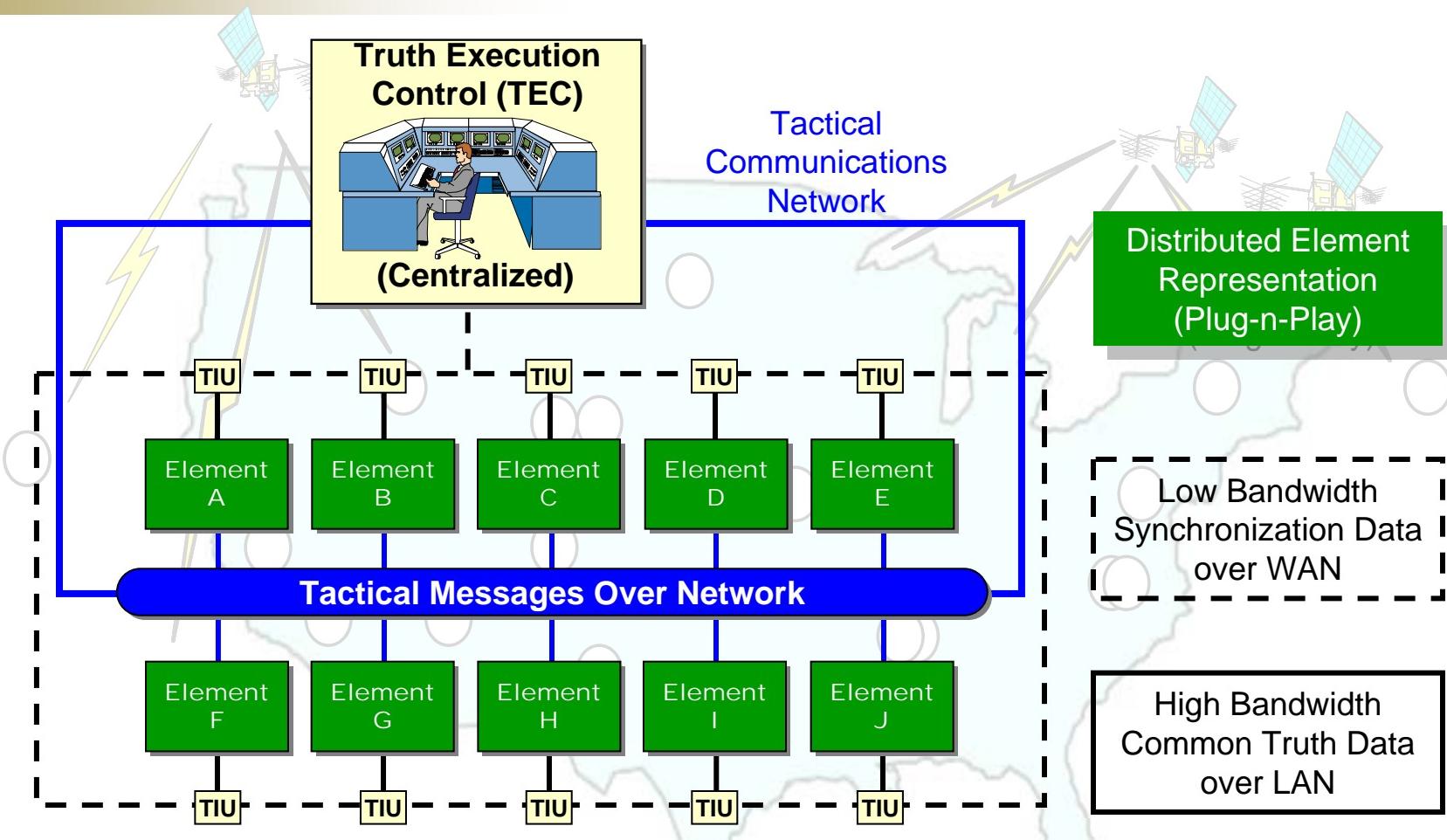
### Truth Interface Unit – Portable (TIU-P)

- Smaller Storage Capacity than TIU-R
- Dual or Quad-Core Processors capable
- Limited Environment Stimulation capability
- TEC-Capable
- Ruggedized/Reinforced, Mobile
- \$\$

### Truth Interface Unit – Laptop (TIU-L)

- Smaller Storage Capacity than TIU-R
- Dual or Quad-Core Processors capable
- Limited Environment Stimulation capability
- TEC-Capable
- Commercial Laptop, Mobile
- \$

# Stimulation Framework Integrated Architecture Summary



The Single Stimulation Framework Provides Centralized Control of Geographically Distributed System Components With Message Traffic Designed to Accommodate Network Capabilities and Allows for Easy System Reconfiguration to Test System Interoperability and Performance